Hydrogen in Energy Systems & Synergies with Transport

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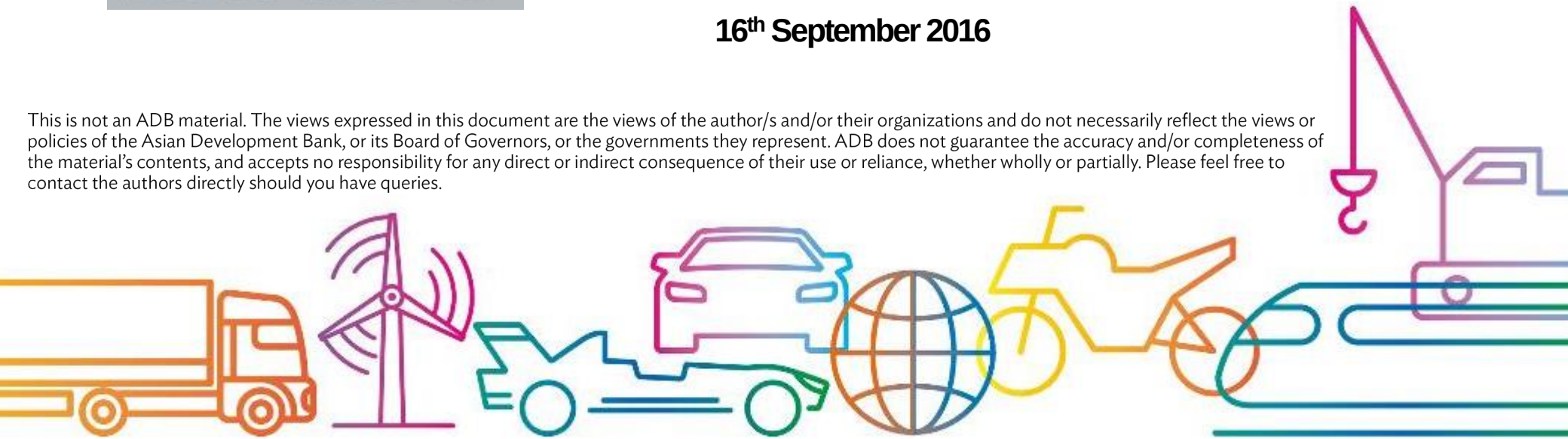
16th September 2016



Energy System – Direction of Travel: Targets

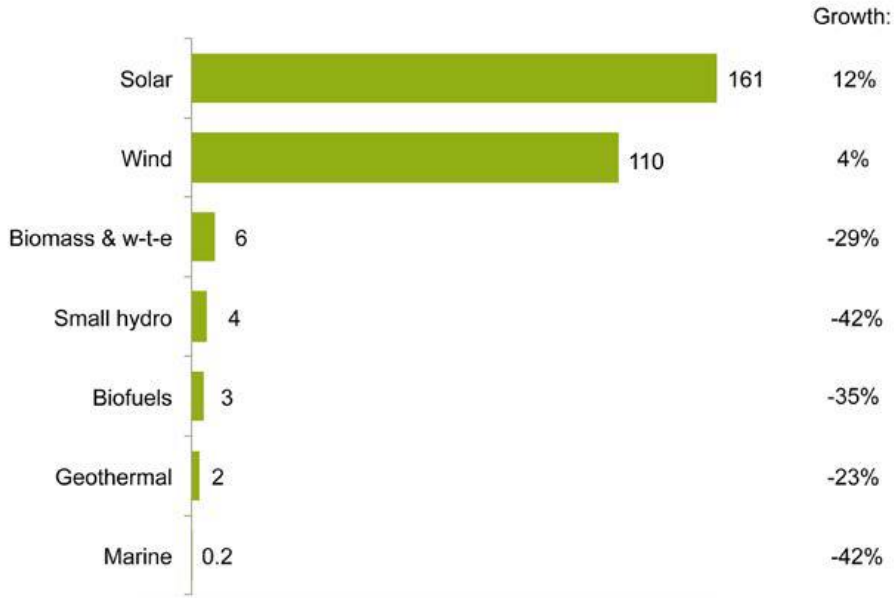
- Transformation to Low Carbon started in the 1990's
- Acceleration in the early 2000's
- Key GHG reduction targets now include:

COP21	EU	UK
• Global temperature rise this century well below 2°C	• 20% by 2020 • 40% by 2030 • 80% - 95% by 2050	• 34% by 2020 • 80% by 2050

Energy System – Direction of Travel: Renewables

- GHG targets have linked renewable energy targets
- Renewable energy targets have linked polices: incentives and enabling measures:
  - Feed in Tariffs or production quotas
  - Grid access
  - Taxation
- Driven rapid development of installations and supply chain – **in renewable electricity**
- COP21 – INDCs suggest that 78% of new power generation will be renewable

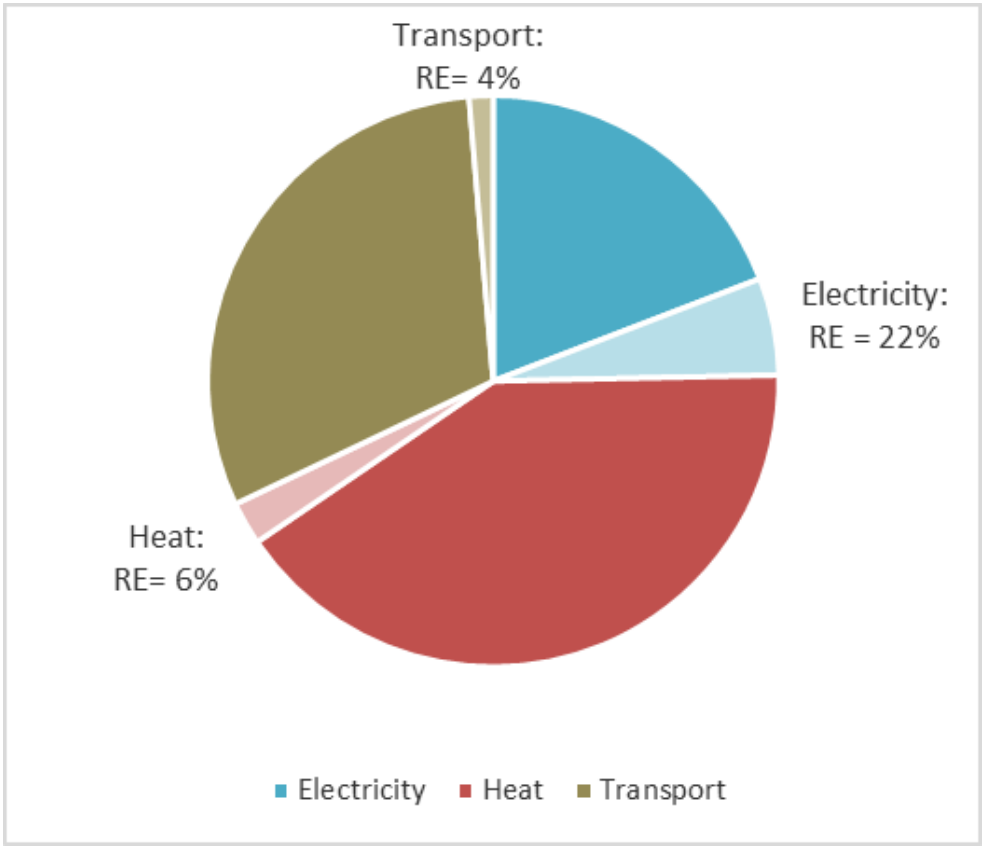
Global New Investment in Renewable electricity 2015 and growth on 2014, $billion



Source: UNDP & Bloomberg

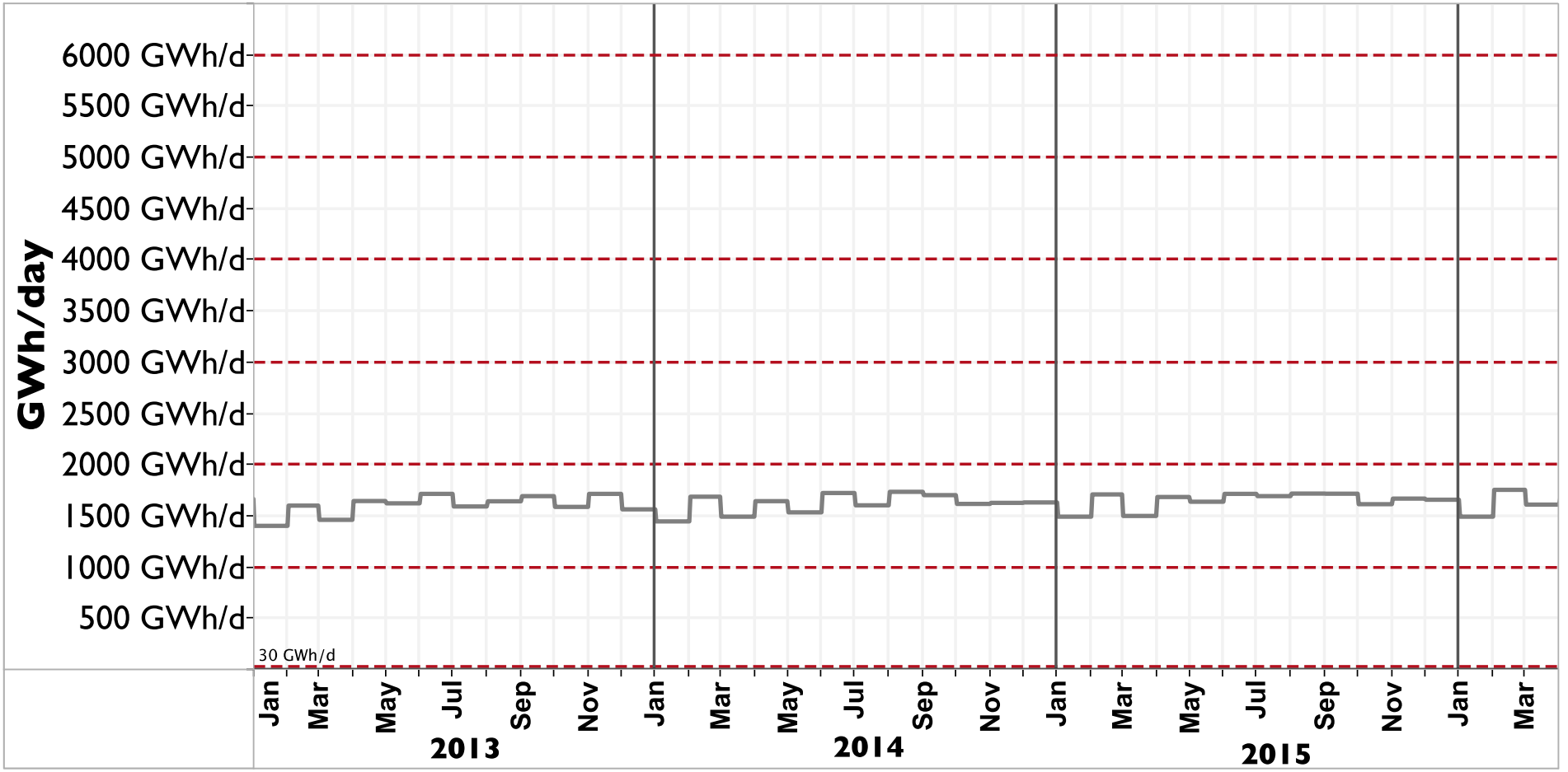
Energy System – Direction of Travel: Not just electricity

- UK Final Energy Demand in 2015



- Heat is twice electricity + slower less progress
- Daily data shows a different picture

Great Britain's Energy – in GWh per day TRANSPORT



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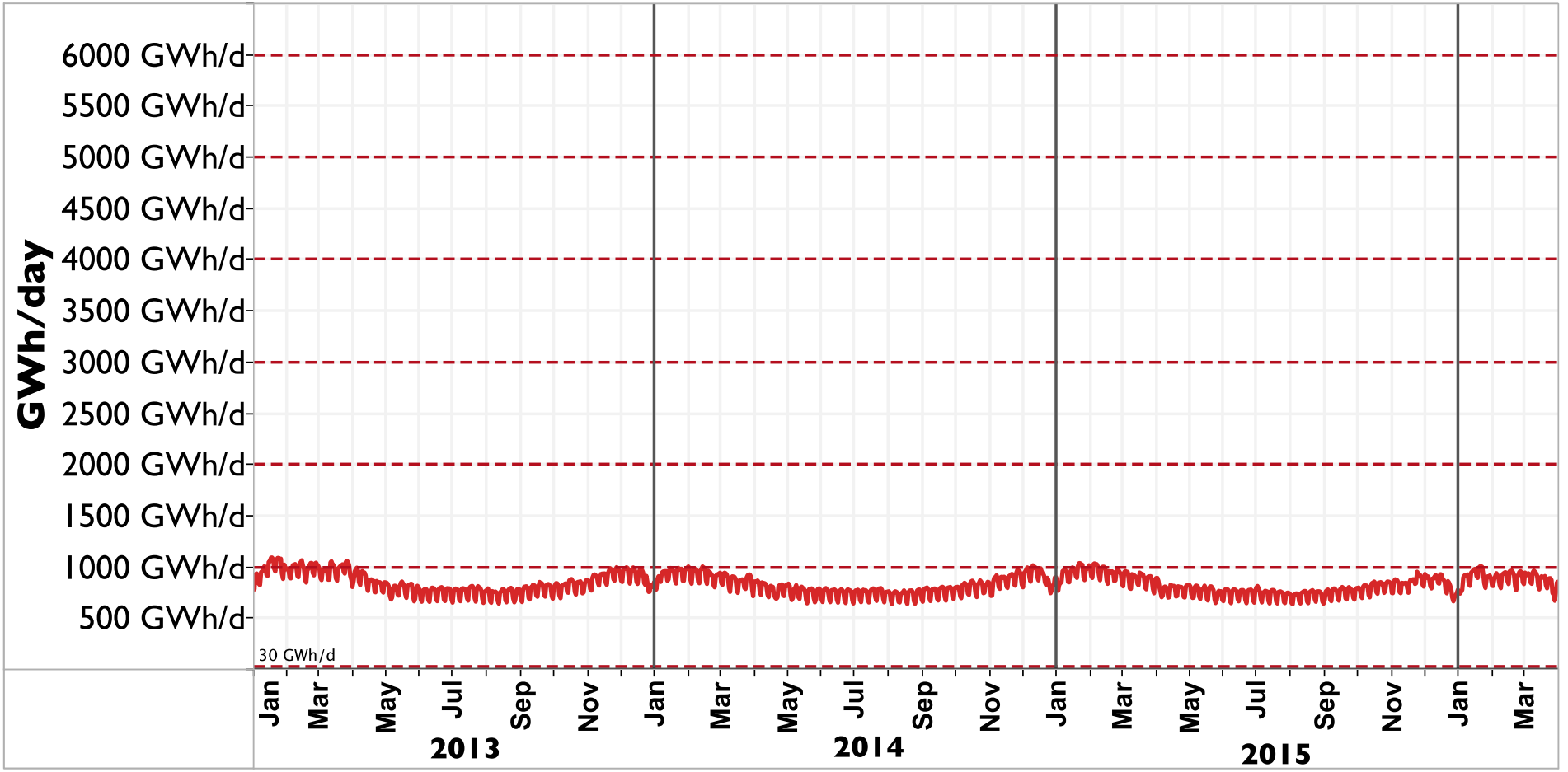
Great Britain's Energy – in GWh per day ELECTRICITY



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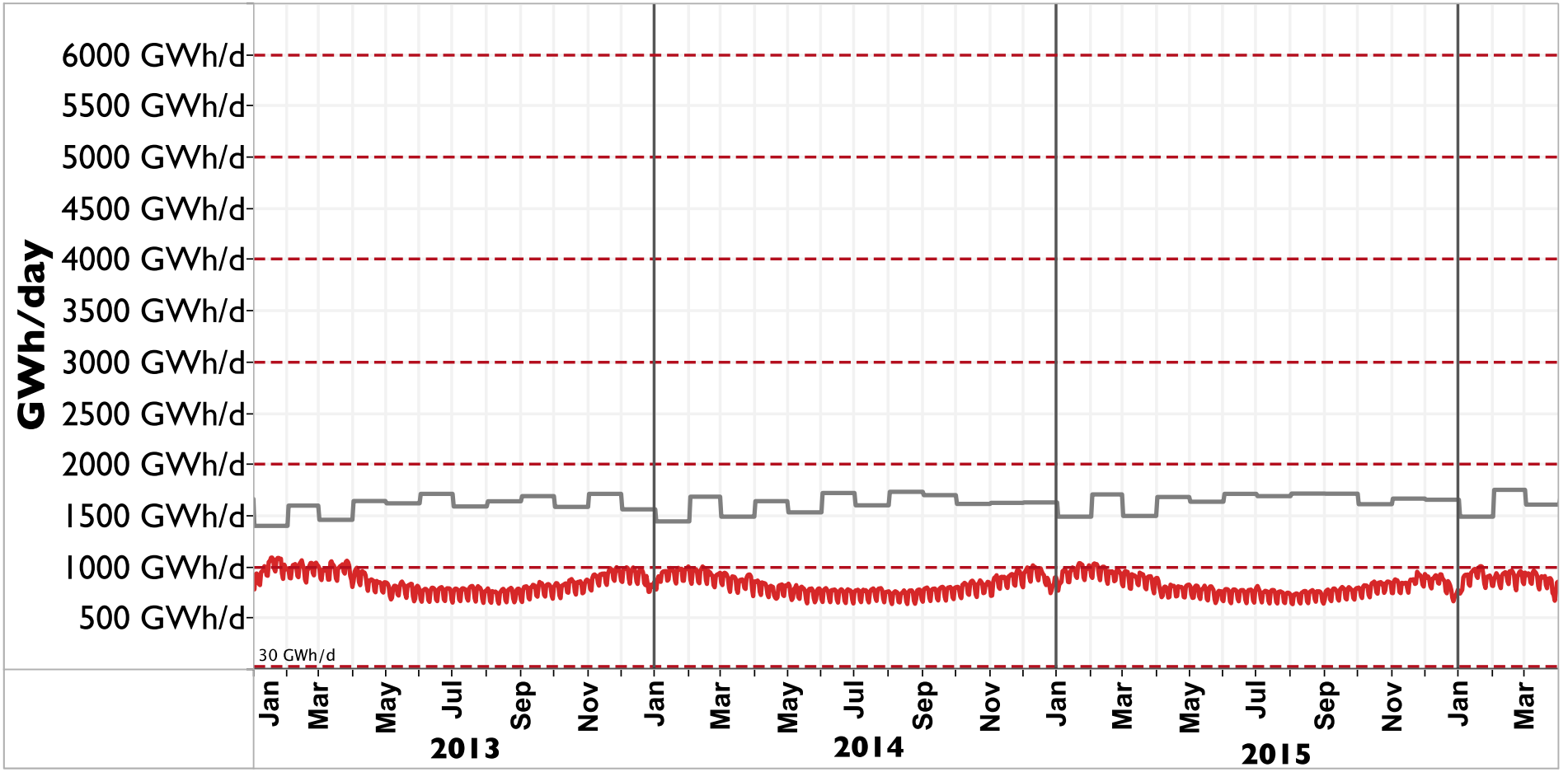
Great Britain's Energy – in GWh per day TRANSPORT + ELECTRICITY



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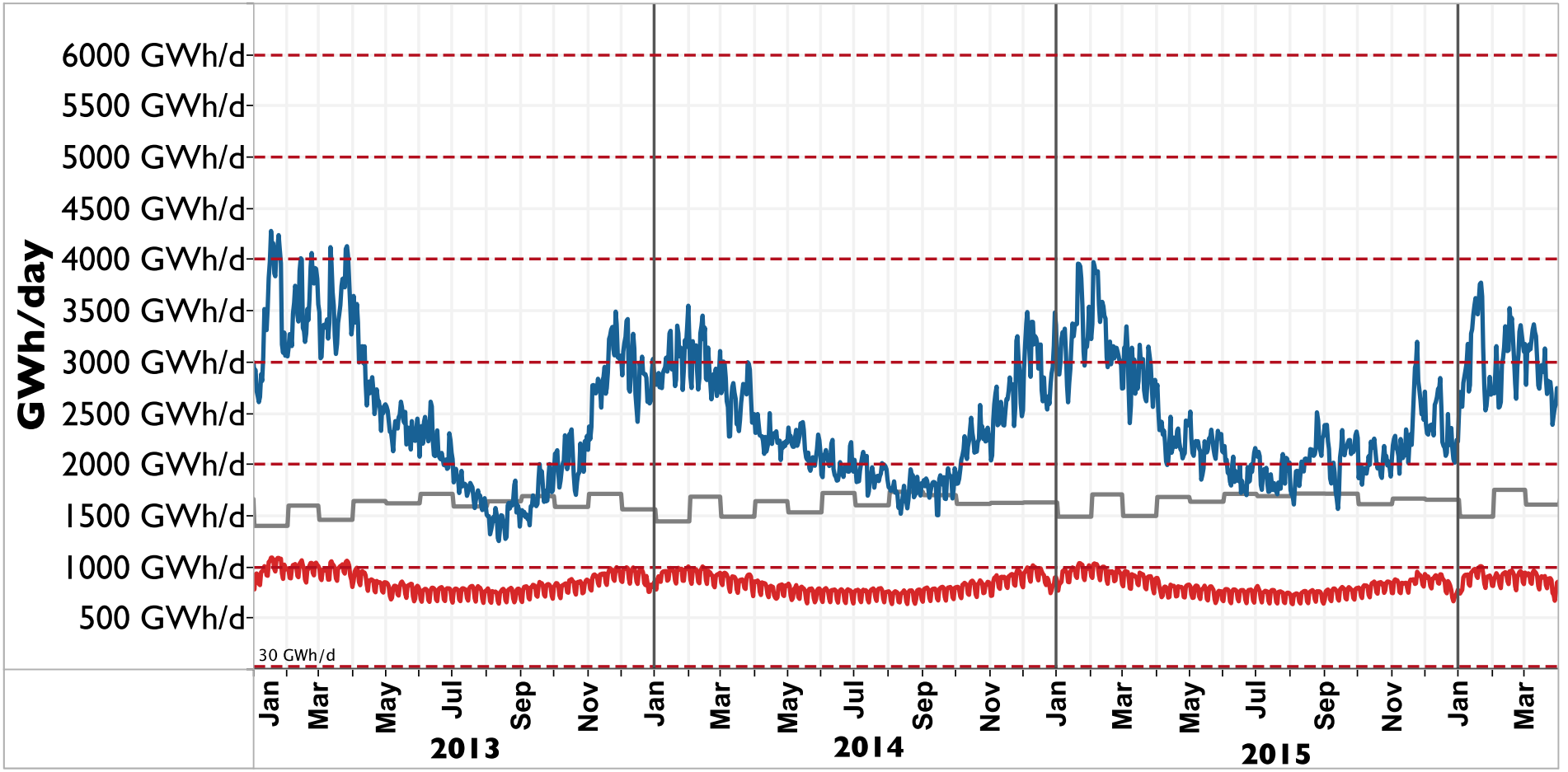
Great Britain's Energy Vectors – TRANSPORT + ELECTRICITY + GAS



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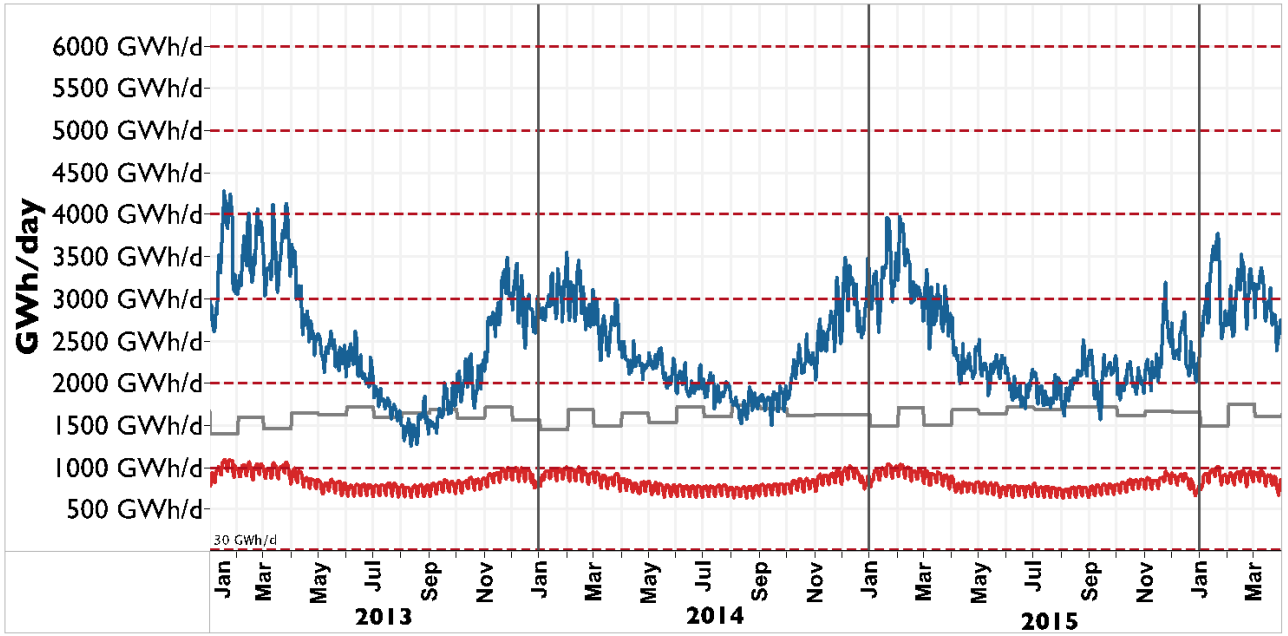
Decarbonising heat

- Greatest energy system challenge is decarbonising heat
  - Wider seasonal swing in consumption than electricity = lower valley + higher peak



  - 80% of current buildings will be in use in 2050
  - 90% of urban buildings use natural gas – gas network assets valued at $29 billion
  - Existing electricity networks cannot handle heat and transport

Options for transforming heat

	Biomass	Heat Pumps	Hydrogen
+ves	• Proven • Accepted by public • Current UK incentive	• Highly efficient (>300%) • Current UK incentive • Adds to winter peak electricity demand	• Flexible: heat, transport & electricity • Cooking as well as heat • Distributed by existing pipeline • Stored in bulk • Production from fossil and renewable sources
-ves	• Limited UK supplies • Land use on a high population density island • Fuel degrades if stored • CO_2 in supply chain • Air Quality at point of combustion	• Some technical issues • Less familiar to public • Need new heat emitters in older buildings	• Public perception • No incentives • Limited experience so far

Case Study – A possible solution

Leeds Citygate H21 project:

- City area with 660,000 population
- 73% reduction in GHG from heat, transport and electricity – by conversion to hydrogen

Key elements:

- Production of hydrogen from methane (1GWth – already proven)
- Carbon capture and storage for CO_2 from conversion
- New gas transmission lines (coast to city)
- Hydrogen daily & inter-seasonable storage (onshore salt caverns – already proven)
- Conversion of medium pressure gas mains to hydrogen (polyethylene pipes already suitable)
- Conversion of all natural gas appliances (boilers, cookers etc.)
- Potential for fuel cell: micro CHP and vehicles

Case Study – A possible solution

But Capital cost £2 billion – Customer costs £100/MWh – including appliances.

More info at: http://www.northerngasnetworks.co.uk/2016/07/watch-our-h21-leeds-city-gate-film/

Conclusions – Hydrogen in the energy system

- Energy system transformation requires big changes in heat and transport as well as electricity.
- Hydrogen offers one route to serve all three with low carbon energy
- Using gas networks is efficient use of infrastructure for a low carbon energy system – with less disruption in urban areas.
- Not new! – town gas (coal gas) was 50% hydrogen + the UK converted all appliances and networks from town gas to natural gas in the 1970's